	General Characteristics	
1	**Abstract of Model Capabilities**	HARM-II is an interactive dose assessment model designed to predict consequences of accidental releases of hazardous materials, either chemical or radioactive. The model combines both passive and heavy gas codes for chemical spills, as well as standard transport and diffusion codes for radionuclide releases. Reactive chemistry is considered for those chemicals with exothermic reaction characteristics. The calculations are performed on a scale of 10 meters to 30 kilometers.
2	**Sponsor and/or Developing Organization**	Department of Energy Oak Ridge Operations Office K-25 Gaseous Diffusion Plant and National Oceanic and Atmospheric Administration Air Resources Laboratory Atmospheric Transport and Diffusion Department
3	**Last Custodian/ Point of Contact**	Will R. Pendergrass NOAA ARL/ATDD P.O. Box 2456 456 South Illinois Avenue Oak Ridge, TN 37831 (423) 576-6234
4	**Life-Cycle**	HARM-II Version 2.01 was developed by NOAA/ARL/ATDD for DOE/Oak Ridge Operations Office (OROO) in October 1991. It is mainly used by the K-25 emergency planning organization, who upkeeps the code.
5	**Model Description Summary**	HARM-II is primarily an emergency management consequence assessment tool that addresses accidental releases of hazardous chemicals and radionuclides. Sources may be located anywhere on the calculational grid. The model makes two sets of receptors available. The first is fixed to a Cartesian calculational grid; while the second is specified by the operator and can be located anywhere within the calculational domain. Emission rates are specified by the user at any time during the simulation through either functional representation, operator input, or stack monitoring. HARM-II considers both passive and heavy gases, as well as aerosols. In addition, releases of uranium hexafluoride can also be considered. HARM-II considers both mechanical and buoyant plume rise. It uses two wind fields. A simplistic $1/r^2$ interpolation is used to initiate the wind field based on available surface wind observations. A mass-consistent model is used to establish the three-dimensional wind field. The calculations are coupled with meteorological site surveys conducted at each OROO facility. For passive releases, standard Gaussian puff algorithms are used with onsite measurements of sigma-theta and sigma-phi. Heavy gas releases are modeled with a Colenbrander-type dispersion algorithm which provides for entrainment of ambient air, deentrainment of contaminants, and smooth transitions. HARM-II includes the production of UO_2F_2 and HF by the reactions between UF_6 and water. HARM-II also includes algorithms that address dry deposition and gravitational settling. For radiological releases, a source depletion model is used.
6	**Application Limitation**	HARM-II is subject to the normal limitations of Gaussian modeling and simple heavy gas models. The model is site-specific, requiring data on local topography and building configurations. The model application is limited to near-field ranges within 50 kilometers of the site.
7	**Strengths/ Limitations**	**Strengths:** Contains algorithms to address passive and heavy gases, chemical transformations and removal mechanisms. **Limitations:** Site-specificity and inherent Gaussian structure.
8	**Model References**	! Pendergrass, W.R., 1990. The HARM-II Emergency Management Models, Volumes 1-3, NOAA, ATDD, Oak Ridge, TN. ! Pendergrass, W.R., 1991. HARM-II: Technical Manual I Operator's Handbook, NOAA, ATDD, Oak Ridge, TN.
9	**Input Data/Parameter Requirements**	Chemical name (library will provide additional information), release coordinates (x_{UTM}, y_{UTM}), stack height, stack temperature, exit velocity, exit diameter, source leak rate, release duration, initial sigma-y, initial sigma-z, wind speed, wind direction, upper-level wind speed and direction, indicator of atmospheric stability, and receptor location.
10	**Output Summary**	Graphical plume overlayed on topographic map with isopleths. Tabular report summaries of downwind concentrations at various receptor locations inclusive of projection centerline, projection receptors, real-time centerline, real-time receptors, and archive report generation.
11	**Applications**	Applications are geared to facilities managed by the OROO. They include Y-12, ORNL, K-25, Paducah, Portsmouth, and Fernald.

12	**User-Friendliness**	Model is user friendly due to strong user-interface, menuing, and prompting commands through input data operations. User is provided opportunities to modify the data throughout the operation. In addition, HARM-II was developed and implemented with a tiered approach to use onsite capabilities, operations office capabilities, and the capabilities of the Atmospheric Release Advisory Capability (ARAC).
13	**Hardware-Software Interface Constraints/ Requirements**	**Computer operating system:** Hewlett Packard Model 9000/375 computer using UNIX X Window operating system or DEC VAX operating system. **Computer platform:** No information provided. **Disk space requirements:** Unknown. **Run execution time** (for a typical problem)**:** Dependent on whether one meteorological measurement is used as input or whether a series of meteorological towers are used to develop a mass consistent wind field. The three-dimensional mass-consistent wind field run requires a significantly larger calculation time. **Programming language:** HARM II is written in standard FORTRAN-77 using VAX extension. **Other computer peripheral information:** No information provided.
14	**Operational Parameters**	**Identify whether the code has any error diagnostic messages to assist the user in troubleshooting operational problems:** **Set up time for:** **Typical times are: *first-time user:* *experienced user:***
15	**Surety Considerations**	**All quality assurance documentation:** The transport and diffusion codes have been evaluated using data sets from DOE Savannah River Site. These evaluations show HARM-II to consistently predict 80-90 percent of the observed concentration to within an order of magnitude and roughly 40 percent to within a factor of 1.5-2.0. **Benchmark runs:** **Validation calculations:** **Verification with field experiments that has been performed with respect to this code:**

Specific Characteristics

Part A: Source Term Submodel Type		
A1	**Source Term Algorithm?**	_✔_YES __NO
A2	**For Chemical Consequence Assessment Models**	**Liquid spill: _✔_ pool evaporation _ particulate resuspension** **Pressurized releases:_✔_ two-phase jets_✔_ flashing__ entrainment__ aerosol formation** **Solid spills: _ resuspension _ sublimation**
A3	**For Radiological Consequence Assessment Models**	**Gaseous releases: _✔_ noble gases _✔_ iodines __ other non-reactive gases** **Aerosol releases:** **Particulate releases:** **_ Chemistry __ Isotopic exchange _ Physical properties capability**
Part B: Dispersion Submodel Type		
B1	**Gaussian**	**__Straight-line plume __Segmented plume __ Statistical plume _✔_ Statistical puff**
B5	**Particle-In-Cell**	HARM-II is a puff advection type model
Part C: Transport Submodel Type		
C2	**Deterministic**	HARM-II is a deterministic model without any prognostic capability
C4	**Frame of Reference**	**_✔_ Eulerian __ Lagrangian __ Hybrid __ Eulerian-Lagrangian**
Part D: Fire Submodel Type (Not Applicable)		
Part E: Energetic Events Submodel Type (Not Applicable)		
Part F: Health Consequence Submodel Type		
F1	**For Chemical Consequence Assessment Models**	**Health effects: __ fatalities __ cancers__ latent cancers __ symptom onset** **Health criteria** **_✔_ IDLH _✔_ STEL _✔_ TLV __ TWA** **__ ERPG __ TEEL __ AEGL __ WHO** **Zones with flammable limits: __ UFL __ LFL** **Blast overpressure regions:** **Fire radiant energy zones:**

F1	**For Chemical Consequence Assessment Models (Cont.)**	**Risk qualification:** **Concentration: _✔_ single value _✔_ time-history __ integrated dose** **Probits:**
F2	**For Radiological Consequence Assessment Models**	**Cloudshine: _ finite cloud _ semi-finite cloud _ other** **Groundshine: _ short-term _ long-term** **Inhalation: _✔_ short-term _✔_ long-term** **_ Total effective dose equivalent** **_ Uptake of respirable fraction of particle spectra** **Resuspension: __ short-term _ long-term __ Anspaugh** **Food/Water Ingestion: __ dynamic _ static** **Skin dose: _ absorption _ other** **Dose assessment: __ ICRP-60 criteria __ organs __ pathways** **Health effects: __ early _ latent**
Part G: Effects and Countermeasures Submodel Type (No Information Provided.)		
Part H: Physical Features of Model		
H1	**Stability Classification Turbulence Typing**	**Pasquill-Gilfford-Turner:** HARM-II uses the seven class (A-G) Pasquill-Gifford-Turner classification system. **STAR:** **Irwin:** HARM-II has an option to use Irwin curves. **Sigma theta:** HARM-II can type turbulence from sigma-theta and sigma-phi measurements **Richardson number:** **Monin-Obukhov length:** **TKE-driven:** **Split sigma:**
H2	**Release Elevation**	**_✔_ ground _✔_ roof**
H6	**Mixing Layer**	**__ trapping __ lofting _✔_ reflection __ penetration** **__ inversion breakup fumigation __ temporal variability**
H7	**Cloud Buoyancy**	**_✔_ neutral [passive] _✔_ dense [negative] _✔_ plume rise [positive]**
H9	**(Radio)chemical Transformation and In-Cloud Conversion Processes**	HARM-II has the ability to address the complex chemistry of UF_6 releases.
H10	**Deposition**	**_✔_ gravitational setting _✔_ dry deposition __ precipitation scavenging** **__ resistance theory deposition __ simple deposition velocity __ liquid deposition** **__ plateout and re-evaporation**
H12	**Radionuclide Ingrowth and Decay**	Yes
H13	**Temporally and Spatially Variant Mesoscale Processes**	**Urban heat island:** **Canopies:** **Complex terrain (land) effects: _✔_ mountain-valley wind reversals** **__ anabatic winds __ katabaic winds** **Complex terrain (land-water) effects: __ seabreeze airflow trajectory reversals** **__ Thermally Induced Boundary Layer definition __ seabreeze fumigation** **__ landbreeze fumigation** **Thunderstorm outflow:** **Temporally variant winds:** **High velocity wind phenomena: __ tornado __ hurricane __ supercane __ microburst**
Part I: Model Input Requirements		
I1	**Radio(chemical) and Weapon Release Parameters**	**Release rate: _✔_ Continuous _✔_ Time dependent _✔_ Instantaneous** **Release container characteristics: _✔_ vapor temperature _✔_ tank diameter** **_✔_ tank height _✔_ tank temperature __ tank pressure __ nozzle diameter** **__ pipe length** **Jet release: _ initial size __ shape** **__ concentration profile at end of jet affected zone**

I1	**Radio(chemical) and Weapon Release Parameters (Cont.)**	**Release dimensions: _✔_ point __ line _✔_ area** Line and area sources are modeled by the manual input of the appropriate σ_y. **Release elevation: _✔_ ground _✔_ roof __ stack**
I2	**Meteorological Parameters**	**Wind speed and wind direction: _✔_single point _✔_ single tower/multiple point _✔_ multiple towers** **Temperature: _✔_ single point __ single tower/multiple point __ multiple towers** **Dew point temperature: _✔_ single point __ single tower/multiple point __ multiple towers** **Precipitation: __ single point __ single tower/multiple point __ multiple towers** **Turbulence typing parameters: __ temperature difference __ sigma theta _✔_ sigma phi __ Monin-Obukhov length __ roughness length __ cloud cover __ incoming solar radiation _✔_ user-specified** **Four dimensional meteorological fields from prognostic model:**
Part J: Model Output Capabilities		
J2	**Graphic Contours and Resolution**	Yes
J3	**Concentration Versus Time Plots**	Yes
J4	**Tabular at Fixed Downwind Locations**	Yes
J5	**Health Effects**	**_✔_ toxicity indices [e.g., ERPG's, PAG's] __ potential fatalities __ cancers __ other adverse effects**
Part K: Model Usage Considerations		
K1	**Ease of Model Use**	**Training required to run the model: _2_ background (years of education)** **_2-4 months_ training time needed on the model to be able to exercise all model capabilities** **Training required to continue development of the model:** **_4_ background (years of education)** **_6-12 months_ training time needed on the model to be able to exercise all model capabilities**
K3	**Ease of Use of Output, Evaluated as the Time Needed to Train a College Graduate in the Use of the Output**	HARM-II output is designed for easy use and interpretation.